NON-PUBLIC?: N
ACCESSION #: 9502130243
LICENSEE EVENT REPORT (LER)

FACILITY NAME: Clinton Power Station PAGE: 1 OF 6

DOCKET NUMBER: 05000461

TITLE: Lack of Understanding of Feedwater (FW) Heater Train
Operation During Removal of FW Heater from Service
Results in Decreasing FW Temperature, Loss of Heater
Level Control, and Manual Scram
EVENT DATE: 01/05/95 LER #: 95-001-00 REPORT DATE: 02/03/95

OTHER FACILITIES INVOLVED: None DOCKET NO: 05000

OPERATING MODE: 1 POWER LEVEL: 79

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR SECTION:
50.73(a)(2)(iv)

LICENSEE CONTACT FOR THIS LER:
NAME: R. T. Chear, Plant Engineer TELEPHONE: (217) 935-8881,
Extension 3664

COMPONENT FAILURE DESCRIPTION:
CAUSE: X SYSTEM: EL COMPONENT: RLY MANUFACTURER: G082
X SD HX W120
REPORTABLE NPRDS: Y
Y

SUPPLEMENTAL REPORT EXPECTED: NO

ABSTRACT:

With the plant at 100 percent reactor Power, operators decided to reduce power to 53 percent of rated t power (RTP) and isolate the B low pressure (LP) feedwater heater string to correct degradation related to suspected tube leaks, in the 5B LP heater. With reactor power at 70 percent RTP and extraction steam to the B heater string secured, operators began to slowly open the (LP) heater string bypass valve. While opening the valve, water levels in the 6A high pressure heater and the A side reheater drain tank began to oscillate to off-scale high causing the 6A heater to isolate from extraction steam. Feedwater temperature decreased 50 degrees and reactor power increased to 79 percent RTP. In response to

these conditions, the shift supervisor ordered the initiation of a manual scram. The cause of this event is attributed to insufficient understanding of heater train operation in an abnormal condition. Personnel did not fully understand the impact that opening the bypass valve would have on the 6A heater operation. Corrective action for this event includes plugging 5B feedwater heater tubes, revising the system operating procedure to incorporate additional guidance for removing a heater string from service and restoring it, and inspecting tubes in the next refueling outage.

END OF ABSTRACT

DESCRIPTION OF EVENT

Operations and Plant Engineering had been monitoring the 5B feedwater SD! low pressure (LP) heater HX! since December 12, 1994, when tube TBG! leaks were first suspected. Condition Report 1-94-12-016 and maintenance work request D50131 were initiated to investigate and correct the condition.

On January 5, 1995, the plant was in Mode 1 (POWER OPERATION) at about 100 percent reactor RCT! power The water level on the 5B heater began to increase rapidly and Operations decided to remove it from service. A common feedwater bypass line is installed between the two strings ("A" and "B") of LP heaters to enable isolation of the 2, 3, 4, and 5 heaters on either string.

At 2003 hours, in preparation for removing the 2B, 3B, 4B, and 5B feedwater low pressure heater string ("B") from service, operators began reducing reactor power by reducing reactor recirculation (RR) system AD! flow. Operators planned to reduce reactor power to about 53 percent of rated thermal power (RTP) and then isolate the "B" feedwater low pressure heater string for repair.

At 2100 hours, with reactor power at about 72 percent of RTP, operators stopped the reactor power reduction using RR flow. At 2122 hours, operators began reducing reactor power by inserting control rods. At 2135 hours, operators stopped the reactor power reduction using control rods at 70 percent of RTP because of significant oscillations in the water level of the 5B heater.

At 2140 hours, operators began removing low pressure heaters 2B, 3B, 4B, and 5B from service, in accordance with system operating procedure CPS 3102.01, "Extraction Steam/HTR Vent & Drains (ES, HD)," by isolating the

extraction steam SE! supply to the 5B heater.

By 2208 hours, operators had successfully secured the extraction steam supply, normal drains DRN! and other heat sources to the 2B, 3B, 4B and 5B heaters. Since isolating the 'B' heater string would cause LP heater string bypass valve V! 1CB007 to open fully, operators were concerned that feedwater temperature would decrease more than 50 degrees Fahrenheit (F). Therefore, at 2220 hours, operators began to open the LP heater string bypass valve slowly, in short increments.

By 2228 hours, the removal of heat sources from the "B" LP heater string and the partial opening of the LP heater string bypass valve had caused the feedwater temperature to decrease by about 50 degrees F.

At 2230 hours, while operators continued to open the LP heater string bypass valve, oscillations began to occur in the water levels of the 6A feedwater SJ! high pressure heater and the "A" side reheater drain tank TK!. The level in the 6A heater increased to off-scale high, causing automatic isolations of extraction steam to the 6A heater and drain flow from the "A" reheater drain tank. These isolations caused the water level in the "A" side reheater drain tank to increase to off-scale high and isolations of both moisture separator reheaters from main steam. The level increase in the 6A heater was due to a drop in its shell pressure (caused by colder feedwater temperatures) to less than the 5A heater shell pressure. Thus, the normal heater drain flow (from the 6A heater to the 5A heater) reversed direction (from the 5A heater to the 6A heater).

At 2233 hours, with the plant at about 79 percent of RTP, operators initiated a manual scram of the reactor as directed by the Operations shift supervisor (SS) by placing the reactor mode switch HS! into the shutdown position. The SS decided to initiate the scram on the basis that the "B" LP heater string was out of service and feedwater temperature already had decreased more than 50 degrees F, and the 6A heater had unexpectedly isolated due to high water level, causing further loss of feedwater heating.

Reactor water level decreased to the low reactor water level (Level 3), initiating close signals to containment isolation valves ISV! in Groups 2 (residual heat removal system (RHR) BO! to upper containment pools), 3 (RHR shutdown cooling) and 20 (miscellaneous valves).

At 2234 hours, reactor water level increased to the high reactor water level (Level 8), initiating a trip of the main turbine.

At 2236 hours, operators manually transferred all electrical busses BU! from the in-house power supply to the off-site power supply and manually opened the main generator GEN! TB! circuit breakers 52! FK! to disconnect the generator from the grid. The generator breakers were opened manually because they did not trip on reverse power.

At 2255 hours, operators confirmed that containment isolation valves in Groups 2, 3, and 20 closed as appropriate in response to the low reactor water level signal by completing off-normal procedure checklist CPS 4001.02C001, "Automatic Isolation Checklist."

By about 2300 hours, the plant was in a stable condition in Mode 3 (HOT SHUTDOWN).

Maintenance work request (MWR) D58734 was initiated to investigate the failure of the main generator to trip on reverse power.

Condition report 1-95-01-003 was initiated to track the root cause evaluation and corrective action determination for this event.

The investigation of the main generator reverse power trip failure identified that one of two reverse power relays RLY! EL! was degraded and incapable of performing its function. The other reverse power relay was out of calibration (on one point, but passed its operational, that is, overall test) and was capable of performing its function. The investigation determined that the reverse power relay scheme operated as designed; the magnitude of the reverse power condition was not sufficient for an adequate time period to automatically cause the generator to trip off

No other automatic or manually initiated safety system responses were necessary to place the plant in a safe and stable condition. No other equipment or components were inoperable at the start of this event to the extent that their inoperable condition contributed to this event.

CAUSE OF EVENT

The cause of this event is attributed to insufficient understanding of heater train operation in an abnormal condition. Operations and Plant Engineering personnel did not fully understand the impact that opening the LP heater string bypass valve has on the 6A feedwater heater operation. The isolation valves for each string of heaters are

interlocked with the bypass valve so the bypass valve opens anytime one of the isolation valves is moved more than 10 percent from the full-open position. During this event, operators were fully aware that feedwater temperature should not be allowed to decrease more than 50 degrees F. Therefore, operators decided to open the bypass valve slowly, in short increments because isolating the "B " heater string would cause the bypass valve to automatically open fully.

Beginning with the 6A (or 6B) heater, each consecutive heater has a lower shell-side internal pressure so drains will flow from the 6A (or 6B) heater through the heater string to the 2A (or 2B) heater and then to the condenser. With the LP heater string bypass valve open any significant amount, the temperature of the feedwater that bypasses the low pressure heaters and enters the 6A (or 6B) high pressure heater is much cooler than the temperature at the outlet of the 5A (or 5B) low pressure heater.

In this event, the cooler feedwater entering the 6A heater caused its shell-side pressure to decrease to below the pressure of the 5A heater. As a result of this decrease in 6A heater shell pressure, drain flow from the 6A heater to the 5A heater reversed direction. The reverse drain flow from the 5A heater caused the water level in the 6A heater to increase faster than the emergency drains could respond, causing the water level in the 6A heater and then the water level in the "A" side reheater drain tank to increase to off-scale high. Because of the loss of heater level control, along with the decreased feedwater temperature, the shift supervisor directed operators to initiate a manual scram.

The cause of the 5B feedwater low pressure heater tube failures is postulated to be vibration-induced tube fretting. A total of 27 U-type tubes were found damaged in the 5B feedwater low pressure heater, 14 tubes were completely severed, seven tubes had substantial openings, two tubes had small fractures without loss of metal, and four tubes had minor leaks but no visible damage.

Plant Engineering and two independent consultants reviewed the 5B heater tube damage and the heater level transient that occurred during this event. The review postulated that one or more tubes had failed due to vibration induced fretting as a result of possible loose fit with the drain cooler end plate holes. The fretting progressed to tube failure at or near the drain cooler end plate and allowed the relatively high pressure feedwater to flow into the bottom of the heater near the level sensor tap. The high pressure feedwater flow on the level sensor caused the level instrument to sense a false high water level condition and the heater level controller to open the drain valve to lower the water level

in the heater. The lower level allowed steam to penetrate the drain cooler section of the heater. The presence of steam in the drain cooler increased vibration of other tubes in the vicinity and caused additional tube failures.

CORRECTIVE ACTION

Based on the knowledge gained from removing the "B" string heaters from service during this event and the ensuing plant shutdown, system operating procedure CPS 3102.01 was revised to incorporate additional guidance for removing a heater string from service and restoring it. The revision includes a provision for installing a temporary modification to remove the interlock between the LP heater string bypass valve and the heater string isolation valves when preparing to remove a heater from service while the plant is at power. This procedure change will reduce the amount of feedwater flow bypassing the operating train and thus will minimize the total temperature reduction of the feedwater.

The 27 damaged heater tubes and 29 adjacent, non-damaged tubes were plugged in the 5B heater in accordance with D5013 1.

Additional tubes in the 5B heater will be tested for wall thinning during the fifth refueling outage.

ANALYSIS OF EVENT

This event is reportable under the provisions of 10CFR50.73(a)(2)(iv) due to the manual initiation of the reactor protection system JC! (scram).

Assessment of the safety consequences and implications of this event identified that this event was not nuclear Safety significant. The event was compared to the Loss of Feedwater Heating and Turbine Trip transients discussed in Chapter 15 of the Updated Safety Analysis Report (USAR) and was determined to be within the design basis of the plant.

ADDITIONAL INFORMATION

The relay that was found degraded during the investigation of this event was a 120-volt, 5-amp, 60-hertz reverse power relay, part number 12GGP53C1A, manufactured by General Electric Corporation.

The 5B feedwater low pressure heater is a horizontal shell/tube heat exchanger manufactured by Westinghouse Electric Corporation. The heat exchanger contains 20 gauge, 0.75-inch outside diameter, SA688, type 304

stainless steel U-type tubes and a 9.125-inch thick, 64-inch diameter, SA105 tube sheet.

Clinton Power Station has not previously reported an event similar to the event described in this LER.

For further information regarding this event, contact R. T. Chear at (217) 935-8881, extension 3664.

ATTACHMENT TO 9502130243 PAGE 1 OF 1

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POWER U-602401
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JGC-049-95
February 3, 1995
Docket No. 50-461 10CFR50.73

Document Control Desk
Nuclear Regulatory Commission
Washington, D.C. 20555

Subject: Clinton Power Station - Unit 1
Licensee Event Report No. 95-001 -00

Dear Sir:

Enclosed is Licensee Event Report No. 95-001-00: Lack of Understanding of Feedwater (FW) Heater Train Operation During Removal of FW Heater from Service Results in Decreasing FW Temperature, Loss of Heater Level Control and Manual Scram. This report is being submitted in accordance with the requirements of 10CFR50.73.

Sincerely yours,

J. G. Cook
Vice President

RSF/csm:

Enclosure

cc: NRC Clinton Licensing Project Manager
NRC Resident Office, V-690
Regional Administrator, Region III, USNRC
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